Science, health, and cultural literacy in a rapidly changing communications landscape

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Edited by Dietram A. Scheufele, University of Wisconsin–Madison, Madison, WI, and accepted by Editorial Board Member May R. Berenbaum March 7, 2019 (received for review April 26, 2018)

There is a gap between how many scientists communicate and how most people understand and interpret messages. This article argues that the extensive science communications literature needs to be joined by the health literacy literature and anthropological work on cultural variations in hearing and understanding messages. Rapid changes and differences in how people in the United States get information are also discussed. Better understanding of how people get and perceive messages, and how access to information and to health services affects their behavior, should be an iterative and interdisciplinary effort. Community involvement in developing communication strategies is strongly encouraged.

communication | anthropology | health literacy | infectious diseases

The current climate in the United States for communicating science is complex. Challenges to clear communication and understanding fall into at least three areas. First, as Scheufele (1) notes, scientists in general have tended to use wording and explanations that are not intelligible to the general public, and even to those in other areas of science. Second, people hear science communication through a series of filters such as generation, culture, language, literacy, and socioeconomic status. Third, as Massey and Iyengar discussed at the National Academy of Sciences (NAS) Sackler Symposium in November 2017, there is polarization at policy and government leadership levels around the value of science itself. "Facts are considered 'soft,' and behavior based on feelings is encouraged" (2). In a NAS report on communication capacity to counter infectious diseases, Daniel describes the concept of a "media village," where people shut themselves off from the outside world to protect themselves and only read material that reinforces existing views. She notes that the scientific community tends to have its own media village (3). Third, people are getting information from a wider and more diverse array of sources than in the past. This paper explores all three areas just described, and makes recommendations for improving science communication in the area of health. In particular, the extensive literature on communication and science communication can benefit from the field of health literacy and the long-standing work of anthropologists on how culture and lived experiences affect understanding and perception of communication related to health.

Summary of Key Concepts in the Science Communications Literature

Table 1 summarizes key concepts in the literature on communicating science and demonstrates the complexity of understanding communication strategies. This complexity indicates that focusing on one aspect of communication is not enough. While the literature ranges from an emphasis on how scientists should communicate to how people perceive messages, to modes of communication, it is clear that all of these need to be considered together. Scheufele (1) argues this point in a 2013 discussion on communicating science in social settings, where he also notes the need for the basic and social sciences to collaborate on science communication. The notations in the summary in Table 1 are discussed and referenced throughout the remainder of this paper.

Clear Communication

The 2017 NAS report on *Communicating Science Effectively: A Research Agenda* (4) provides a thorough and highly relevant analysis of science communication. It focuses on several major areas, including the trustworthiness of the source, contentious issues such as vaccine safety and climate change, the shift away from traditional media, the influence of social networks, and the problem of media hyperbole and limited focus. These are all very important areas. The report grapples with changes in how sources are perceived and trusted, inconsistency in the quality and duration of media attention, and social network influences that are magnified by Internet communications. The report also highlights the "deficit model" of science communication, which assumes a lack of knowledge and understanding of science as a key reason for failure to accept and act on science communication. As noted in the report, this model is wrong, since research shows that audiences may understand what scientists know, but may "not agree with or act consistently with that science." A focus on knowledge alone is not enough (4). As discussed below, knowledge is acquired and filtered through people's identities and lived experiences, and this influences how it is interpreted. In addition, scientists have a strong tendency to use language from their own discipline when attempting to communicate, and many do not even communicate effectively with scientists in other disciplines (5).

Allen et al. (6) and Parson et al. (7) discuss the idea that it is essential to recognize the need for scientists to go beyond the boundaries of the linguistic and conceptual frameworks of their disciplines in communicating to the public and to scientists in other disciplines. Fischhoff discusses in detail how the complexity of our terminology is a barrier, the confusion when evidence leads to changes in findings and recommendations, and the difficulty of communicating uncertainty (8). Braschers maintains that we are too hesitant to communicate uncertainty for fear of creating anxiety, and suggests that health communication practice include carefully developed discussions of uncertainty (9). Han et al. (10) present an integrative conceptual taxonomy of uncertainty that provides strategies for managing the communication of uncertainty in health care settings.

This paper results from the Arthur M. Sackler Colloquium of the National Academy of Sciences, "The Science of Science Communication III," held November 16–17, 2017, at the National Academy of Sciences in Washington, DC. The complete program and audio files of most presentations are available on the NAS website at www.nasonline.org/Science_Communication_III.

Author contributions: S.C.S. wrote the paper.

The author declares no conflict of interest.

This article is a PNAS Direct Submission. D.A.S. is a guest editor invited by the Editorial Board.

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Published online April 15, 2019.

Table 1. Issues related to health and science communication

Information source	Mode of communication	Recipient	Complicating issues
Trustworthiness	Scientific literature	Sociodemographic variables are associated with media choice	Disagreements among scientists regarding facts and interpretations
Use of Knowledge Deficit Model	Traditional media: print, television, radio	Beliefs go both ways: scientists and recipients	Evidence changes over time with new research
Scientific insider Terminology	Fewer trained science journalists	Belief formation is iterative, not linear	Academic reward systems focus on communication between scientists, not from scientists to the public
Lack of understanding of cultural, linguistic, community and other recipient barriers	Digital media: Internet searches, Twitter, Facebook, LinkedIn, Instagram, blogs, podcasts, widgets, etc.	Individuals choose media to meet their needs	Public and political disagreement about science and scientific knowledge
Differential framing by source	Rapidly changing modes of communication and social network sources	People use multiple communication forms	Media hyperbole
Lack of collaboration between bench and social scientists	Shift away from traditional media	Impact is not uniform across segments of society: facts are interpreted differently	Media short attention span and limited focus
	Credibility of social network and digital sources	Values play a role in information processing	Misunderstanding of theory as uncertainty and speculation
			Communicating risk

Scheufele (1) discusses the academic pressures on scientists to communicate in scientific language and in traditional venues such as journals and professional conferences. To a nonspecialist, terms such as epidemic, endemic, genetic load, polygenic risk score, risk, herd immunity, infectious, transmission, and nocturnal are either completely unclear or assigned incorrect meanings. We need to pay close attention to what people are hearing and asking. For example, the misunderstanding around the concept of a theory stems from the lay belief that a theory is speculative, just an idea, while, in fact, scientists develop theories based on rigorous testing of hypotheses. The word "theory" can carry different meanings, and this allows some nonscientists to dismiss scientific theories, such as the theory of evolution, that their religion or belief system encourages them to reject. Eveland and Cooper (11) point out that the process of belief formation is iterative and changes in interaction with communication. They also note that we have to treat beliefs as real to those who believe them, even when they contradict scientific knowledge. Anthropologists would refer to the iterative process in belief formation as lived experience, where we change based on our experiences rather than remaining static in our beliefs and behaviors. This contradicts the idea that we can describe cultures without expecting them to change. The dynamic nature of cultures argues against stereotyping, which is often based on static and outmoded views of cultures. Not only are cultures constantly changing, but there are subcultures based on place of origin and experience. For example, in the United States, there are generational and country of origin differences in the Latino/Hispanic cultures, and rural/urban, regional, and country of origin differences in African Americans.

The concept of beliefs as real to those who believe them is described by anthropologists as "emic," or insider views, as contrasted with "etic," or outsider views. The anthropological literature discusses the need to take both into account when designing health messaging and interventions. In one example from Central America, the insider view was that *Ascaris* worms (stomach worms) in children were normal since most or all children have them and "they come from eating sweets." The outsider view is of a parasitic nematode contracted from ingesting eggs found in the soil, deposited there due to lack of indoor plumbing. Children play in the dirt and put their unwashed hands in their mouths. The villagers' primary concern with "worms" was that they become "agitated" during the rainy season due to thunder and lighting, and they become evident during gastrointestinal infections. From the outsider perspective, sanitation is worse during the rainy season, and children are more susceptible to diarrheal disease. The successful health campaign to get the community to accept deworming medicine was timed for the weeks just before the beginning of the rainy season and featured: "Get rid of your children's worms before the thunder and lightning arrive" (12).

The anthropologist Margaret Mead was known, and criticized, for communicating in clear language to the broader public. She believed that language was key, and emphatically stated that anthropologists are supposed to be good at languages and need to use this skill to speak plainly and clearly when they communicate with nonanthropologists. It was interesting to observe at the 2017 Sackler Symposium, where scientists were discussing communication, how many continued to use the insider language of their own disciplines. Beyond general scientific terminology such as theory, "hypothesis," "clinical trial," and "experiment," each discipline has specific language, and, as Dr. Mead experienced, there is peer pressure to use that terminology. Recently, McKenna noted: "The first challenge is to put people with reliable information into a position where the public will listen to and believe the message they need to hear. The second challenge is to communicate risk and information in language the public already uses. This is not the language that we use, that you use among yourselves, or that you use when you are speaking to me and people like me. Speaking in jargon and insider language is something everyone with expertise in a field does," she said, "but delivering messages the public will receive and understand requires resisting that tendency" (13).

Luntz (14) expresses that concept in writing about *Words That Work: It's Not What You Say, It's What People Hear*, where he urges us to use small words and small sentences. Similarly, Scheufele's work on framing messages discusses ways to understand your audiences and create messages accordingly, including feedback loops to continue ensuring that messages are communicated as clearly as possible based on audience perceptions and

reactions (15, 16). In his recent book *Uninformed: Why People Know So Little About Politics and What We Can Do About It*, Lupia (17) argues that framing can have an impact in increasing knowledge and competence. Kreuter et al. (18) note that proper framing is essential to community acceptance of concepts and programs. As with many of the concepts outlined in Table 1, communication styles and framing are intertwined with how messages are heard.

How We Are Heard: Communication Reception Filters

"I know that you believe you understand what you think I said, but I'm not sure you realize that what you heard is not what I meant" (attributed to Robert McClosky, US State Department).

What people say and how they say it, and what people hear and understand can be filtered by at least the following (19):

- Language
- Gender
- Age (younger, elderly)
- Low literacy
- Low Internet/social media literacy
- Economic status
- Ethnicity/culture (not just language)
- Social class
- Political ideology
- Lived experiences
- Blindness
- Hearing difficulties

For the purpose of this discussion on science communication in general and health communication in particular, the 2017 NAS workshop report on *Building Communication Capacity to Counter Infectious Disease Threats: Proceedings of a Workshop* (20) provides a detailed and important analysis with guidelines for improving infectious disease communication. While it is difficult to add to the thorough analyses in that report, literacy, ethnicity/culture, and socioeconomic status are particularly important to examine.

Literacy vs. Cultural Meanings

The concept of literacy is traditionally associated with the ability to read. As discussed in the 2004 Institute of Medicine report *Health Literacy: A Prescription to End Confusion* (21), health literacy goes far beyond the ability to read, and includes the cultural meanings of words and concepts. I would argue that the same is true for science literacy. Before expanding on the cultural and experiential meaning of words and concepts, it is important to note that the inability to read is a major obstacle for health and science communication in the United States.

A 2013 report from the US Department of Education states that 14% of the US adult population cannot read and another 21% of adults in the United States read below a fifth-grade level (22). This means that over one-third of US adults will likely experience difficulty in understanding and interpreting messages around science and health. Most medical informed consent forms are written at a high-school reading level or beyond (7, 21).

Improving the literacy level by simplifying health communications is not enough. Cultural meanings of words and concepts vary. For example, research on seizure disorders in diverse US ethnic groups revealed that the word "trauma" has two meanings, both in Spanish and in English. It can mean a physical blow, or it can mean an emotionally shattering experience such as seeing someone killed. Neurologists use the first meaning when discussing the possible cause of seizures with a patient. In Latino cultures, trauma is more often understood as the second meaning, an emotional shock. Thus, a neurologist using the word trauma will assign a different meaning to that word than will most Latino patients (23). Similarly, in work by Alcalay et al. (24) to develop educational materials for pregnant women in Mexico and in Los Angeles, the word "risk" was initially translated literally as "riesgo." Focus groups with the women revealed that riesgo did not convey the intended meaning of risk in pregnancy. The women supplied the word for danger, or "peligro," as a more accurate way to convey pregnancy risk to them. Although written within the context of political science, Lupia (25) has a useful discussion of the importance of perceived meaning in communication in his recent book, *Uninformed: Why People Know So Little About Politics and What We Can Do About It*. Kunda's work also discusses ways in which the same scientific facts will mean different things to different audiences, depending on which values or beliefs most motivate their information processing (26).

In addition to variations in what words mean to people, there are conceptual differences in understanding disease. For example, Kendall et al. (27) discuss the fact that dengue is endemic in Puerto Rico, and is transmitted by the *Aedes aegypti* mosquito. Dengue hemorrhagic fever occurs sometimes in individuals who experience repeated infections with dengue, and can be life-threatening. Attempts to get people to engage in mosquito control behaviors ran into difficulties because the flu-like symptoms of dengue were not seen as a major problem. Only dengue hemorrhagic fever was recognized as a major threat, and it is rare, so the attitude was "Why bother with mosquito control?" Interventions were developed to explain that dengue can lead to dengue hemorrhagic fever, so mosquito control is important to prevent that serious complication.

There are many more examples of filters that have an impact on how people perceive messaging around diseases (the etic or outsider view) and illness (the emic or insider view) in the anthropological and related literature (28). Hewlett and Hewlett (29) provide examples from the Ebola epidemic. Awasthi et al. (30) discuss how contrasting insider and outsider views helped improve communication about pneumonia in children under 5 y of age in rural northern India. In addition to messaging, however, health communication needs to take feasibility into account. I will never forget accompanying health workers in a shantytown in Panama and hearing them tell mothers to wash their babies with distilled water and castile soap. Any kind of water was at a premium in this neighborhood, which had no running water, and distilled water was not affordable even for drinking, nor was expensive castile soap an economic option.

Similarly, recent efforts to prevent exposure to the Zika virus in parts of the US mainland and Puerto Rico ran into multiple obstacles. Risk of infection and the consequences of that infection had to be communicated, along with mosquito behavior and how to avoid bites. When the sexual transmission possibility became apparent, differing political views on ways to prevent sexual transmission created obstacles to communication, as there was some political opposition to recommending condom use. Finally, as in the Panama example above, we assume what we recommend is possible: More than 8 mo after experiencing Hurricane Maria in September 2017, Puerto Rico was still without power for air conditioning in many areas, so windows remained open and damaged houses continued to allow access to mosquitos. Both Houston and Miami faced the same problems after hurricanes in August and September of 2017.

The 2017 NAS workshop report on *Building Communication Capacity to Counter Infectious Disease Threats* (20) mentioned earlier contains a detailed analysis of the experience in attempting to communicate risk during the West African Ebola outbreak in 2014. The outbreak provides a clear example of the need for interdisciplinary collaboration on infectious disease communication. Early efforts at communicating risk were met with resistance based on perceived interference with local customs as well as many conceptual differences in the understanding of the disease and risk. In the workshop report (31), Rimal said: "Communication seldom occurs in a social, political, or cognitive

vacuum, and the result is that messages are distorted." Rimal's point was that it is important to remember to look at behavior change from the perspective of the target audience, which is often different from a disease prevention perspective. Again, this illustrates the importance of taking into account both insider (emic) and outsider (etic) views. For example, God and witchcraft were both blamed for Ebola in Liberia. A group of anthropologists formed an Ebola response anthropology platform that illuminated miscommunications and misunderstandings, and suggested strategies for addressing them (32). Their work also illustrated the critical need for communication and collaboration across areas of science ranging from basic laboratory work on infectious diseases, to medical practice, to the social and communication sciences (33).

In sum, it is essential to understand cultural and linguistic parameters for the group you are trying to reach and that one message does not fit all. Building rapport with communities allows us to work with sources trusted by community members. These sources are often practitioners from multiple sectors such as health, education, religious institutions, and government as well as other community members and lay leaders. Iterative consultative and action relationships with community members increase the likelihood of producing successful communication strategies. Southwell et al. (34) provide detailed examples in their book, *Misinformation and Mass Audiences*. Ekwenugo et al. (35) discuss building community capacity for cancer prevention and control. Community engagement strategies may go beyond media outreach and community meetings to include stories, music, and theater productions that illustrate data and desired behaviors. While speaking of the efforts of the CDC to communicate regarding Zika, Lyon Daniel emphasizes how valuable community engagement is in the risk-communication-and-response process. "If you do not engage the community and you do not understand what they are saying, you will not understand what they are hearing. It is not what you say; it is what they hear. They have their own experts and their own people they are paying attention to," she said (3).

It is also important to understand the feasibility of the behaviors you are seeking, and to take into account access to engaging in these behaviors in the light of economic and other constraints. People who are economically stressed may have more urgent priorities than the health behavior you are trying to influence.

Sources of Health Information in Our Current Society

Various recent NAS reports cited earlier discuss the changes in how people currently obtain health and scientific information. The Pew Research Center annually tracks information sources for the American public, and this remains a lively topic in the communications literature. There continues to be a shift away from newspapers and television, particularly in the younger age groups, at least in the United States. There is a shift to Internet websites, social media, and Internet contacts. For example, a recent Pew Research Center report notes that 78% of 18- to 24-y-olds use Snapchat and 45% use Twitter (36). In a nationally representative sample, age emerged as the single strongest predictor of both social networking and blogging (37). A recent British study shows that even publications from traditional print sources are more likely to be read on the Internet by young people (38). Kim and Xie (39) discuss the need to consider this trend for people with low literacy skills, and recommend developing new health literacy screening tools to determine ability to use eHealth services. They suggest that mobile applications (apps) can be tailored to people with low health literacy to allow their use of eHealth services.

In a 2007 national survey, ∼69% of the US population reported having access to the Internet. By 2018, the Pew Research Center reported 68% of Americans use Facebook and nearly three-quarters access YouTube (36). As noted, there are differences by age, where use decreases after the age of 65 y, but there were essentially no gender differences. Education was a different matter, since only 50% of high-school graduates reported Internet use in contrast to 91% of college graduates. There were also strong race/ethnicity differences with "white" and "other" respondents reporting use at 75%, dropping to 56% reported use for African Americans and 49% for Hispanics (37). Jensen et al. (40) also document that individuals with low health literacy skills were less likely to use Internet technology and that males, older participants, and those with less education were less likely to search for health information online, reinforcing earlier findings from the national assessment of adult health literacy (41). These trends continued in the Health Information National Trends Survey in 2012 (42). The age and educational level differences are also documented by the Pew Research Center (36).

Internet use involves search engines that steer people to websites, often influenced by being paid to direct people to a specific site. As recent national events around attempts to influence US elections have revealed, people's search and buying habits can be used to design advertisements to influence behavior and spread misinformation (43). As early as 2003, Fox and Fallows (44) reported that the Internet is apparently used both as a primary information source (e.g., diagnosing illness, checking symptoms) and as a means for further investigation following physician consultation. All this raises questions of media literacy. How do people judge the credibility of a source? Is that important to people? What about the issue of trust, as people reject and distrust sources with which they disagree? As discussed earlier, trust can vary by socioeconomic status, culture/ethnicity, education, language, literacy, political ideology, and other similar parameters such as social networks. How do scientists help people understand that scientific findings change as research progresses, and that earlier findings are sometimes contradicted? How do we help people deal with competing data? How can we manage social, religious, and political motivations for questioning scientific data? More interdisciplinary work involving collaboration between the basic sciences, communication research, and social and behavioral sciences is needed to help us further understand these variations. As some of the examples provided earlier reveal, developing appropriate messaging and channels of communication can be very specific to each group or community, so there are few quick and easy strategies.

Today, media sources beyond print, television, and radio include Twitter, Facebook, LinkedIn, Instagram, blogs, podcasts, Snapchat, and widgets (graphical user interfaces that display information and invite the user to act, such as dialogue boxes, pop-up windows, pull-down menus, icons, and scroll bars). Text alerts, as with weather and traffic, are now also conveying news. Apps provide interactive instructions in areas such as baby care, cooking, gardening, exercise, and diet. There is a mobile phone infectious disease dashboard app for journalists (45). The websites of various national agencies working in health reveal a range of efforts to be more responsive to current ways in which people obtain information on health. In particular, the CDC has developed a number of apps for public use, including a health-and-fitness app that takes infectious disease into account.

All this assumes that people are accessing these sources. Print readership has fallen dramatically, unless accessed through the Internet. There is wide variation on who accesses television news. In the discussion of the media village referred to earlier, it was clear that people in the United States increasingly focus on sources that are consistent with their beliefs and political preferences. More and more, we need to use techniques developed for marketing to understand and communicate with the many segments in our science and health information "market."

Summary and Conclusions

Those working in the health sciences need to embrace strategies for communicating effectively with the general public. To do this well, it is important to understand that people hear science communication through a series of filters such as generation, culture, language, literacy, and socioeconomic status. In addition, there is polarization at policy and government leadership levels around the value of science itself, and this has spread to the general public. Scientists, elected officials, and political appointees are making conflicting statements about scientific findings and the value of science, and this has generated confusion. It is also essential to understand that people are getting information from a wider and more diverse array of sources than in the past and that information sources are changing rapidly. This is complicated by the fact that different groups such as ethnic, generational, and educational levels will access different information sources. Political affiliation is playing an increasing role as well. Failure on the part of scientists to use current sources of information is likely to lead to failure to communicate effectively with segments of the population. Because people differ in the sources on which they rely, messages should use all available sources and formats to leverage evolving information sources in the digital age.

New sources of information are emerging constantly and rapidly. The potential for science and health communication is enormous if trust can somehow be developed and sources that are incorrect or deliberately provide misinformation can be countered with accurate information and if people can learn to critically assess the credibility and accuracy of sources. It is increasingly important to have a system of continuous monitoring for commonly used current communication methods and misinformation, strategies for quickly countering incorrect information with fact checking, and a system of accountability to address false information. Rapid change in sources of information, the influence of social networks on opinion, and the range in accuracy and quality of health information require ongoing research regarding sources of information, trust of these sources, and resulting opinions and behavior. As noted earlier, health communication needs to be an iterative process. This research and communication from and with populations cannot take years. It is important to continue to develop tools such as those used by organizations such as the Pew Research Center, the Kaiser Family Foundation, other foundations, and some federal agencies, which collect data frequently using a variety of methods to update our understanding of health communication.

It is important to understand cultural and linguistic parameters for the group you are trying to reach: One message does not fit all. This can be accomplished, in part, by identifying and working with sources that are trusted in communities and with health practitioners from multiple sectors. An iterative, consultative, and action relationship with communities is essential to understanding the feasibility of desired health behaviors and the economic and other barriers to action. As in the case with Ebola, this understanding and community partnership can lead to strategies to enable desired behavior, in conjunction with clinical and epidemiological measures.

To understand the linguistic, cultural, community, and other strategies for effective communication and behavior change, the integration of social, communication, and health sciences is essential to build capacity in cultural and linguistic competency in science communication. Some social sciences such as sociology, political science, and psychology have been stronger contributors to our understanding of communication than others such as anthropology and literacy. Populations will benefit from a broader range of social sciences pairing with the basic and health sciences to understand and improve communication. Capacity building in science communication and preparedness require funding, political will, and solid interdisciplinary work on the science of threats to health and the science of communication. The academic community needs to understand and value the need for scientists to communicate effectively beyond their disciplines, particularly by avoiding jargon. The burden, however, cannot be completely on scientists. Academic institutions, foundations, and government and other agencies need to have media staff skilled in translating scientific findings into public messages through multiple media channels and tailored to multiple segments of the population. Media entities need to be encouraged to continue and increase the number of staff skilled in reporting on science.

The National Academies of Science, Engineering, and Medicine have come a long way in stepping up to these challenges in recent years in their role as advisor to the nation. It is important to recognize the unique value of that role, to continue efforts to clearly communicate the complexity as well as the value of science, and to provide actionable information based on the best available evidence for the implementation of the health sciences in assuring individual and community health. In particular, these national academies must continue and even enhance their work in briefing elected officials on the best science and best practices relevant to policy.

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